B-1420
November 1982

Economic Implications of Alternative Cotton Production Strategies in the Lower Rio Grande Valley of Texas, 1973-78

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Contents

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INTRODUCTION

Many pesticides are produced from fossil fuel and with declining world fuel reserves, the cost of the chemicals and cost to apply them for pest control are increasing. This cost impact, along with developing pest resistance to pesticides, is providing an ever-increasing incentive for more efficient methods to produce agricultural crops. Integrated Pest Management (IPM) is an opportunity to more effectively control pests and more efficiently produce agricultural crops. Cotton is a crop where the potential benefits to producers and society in general appear especially optimistic (Collins, et al., July 1979; Condra, et al.; Masud, et al.; Taylor and Lacewell).

The quantities of insecticides used per acre by cotton producers in the Lower Rio Grande Valley (LRGV) of South Texas have been among the highest in the nation (Frisbie, et al.). This is due to the favorable climatic and agricultural conditions for several insect pests. Increased insecticide resistance has been a significant problem. With increasing insect resistance to insecticides, farmers tend to increase the number of insecticide applications and rates which further irritates the problem. Even with the use of large amounts of insecticides, the control of damaging insects often has been less than satisfactory.

Until introduction of synthetic pyrethroid insecticides in combination with cottonseed oil as a carrier, farmers were unable to control mid- and late-season tobacco budworm, *Heliothis virescens* (F.), infestations which are often aggravated when beneficial insects and spiders are destroyed by early season boll weevil, *Anthonomus grandis* (Boheman), and fleahopper, *Pseudatomoscelis seriatus* (Reuter), control measures (Namken and Heilman). In some cases in the past, more than 20 applications of insecticide have had only limited effectiveness (Frisbie, et al.). Relatively large per-acre insecticide applications and continual cotton yield losses from insects have strong implications relative to product profits.

In the LRGV, cotton production hazards are many. The crop cannot be planted too early because of low soil temperature and danger of frost. A mandatory stalk destruction deadline of September 1 to reduce the food supply of overwintering insect pests also limits the growing season. The probability of increased rainfall in August and September threatens yield and quality at harvest time. Although chemicals have reduced crop losses from weeds, insect control continues to be a very large part of total production costs (Extension Economists-Management).

The purpose of this report is to investigate the economic implications of an IPM system for cotton production in the LRGV. This new system is termed a short-season cotton production system.

Characteristics of Cotton Production

There are two basic differences in producing short-season and conventional cotton in the LRGV. First, there are physiological differences, i.e., differences in varieties. The short-season cotton variety (semi-determinate) is one which tends to fruit over a relatively short period of time, while the conventional cotton variety (indeterminate) tends to fruit over a relatively long period of time (as long as growing conditions are favorable). Second, there are differences in the management techniques for short-season and conventional cotton production. Through appropriate management techniques — reduced and timely irrigation, fertilizer and insecticide application — it is possible to induce early fruiting and other determinate characteristics in conventional cotton varieties.

KEYWORDS: Integrated pest management strategy/overwintering insect pests/cotton/insecticides.

Conventional Cotton

In the past, cotton varieties that yield high quality fiber and command a premium high price have been grown in the LRGV. When a conventional (long-season) cotton that requires 160 to 180 days to mature is grown, some harvesting can be expected in August or later. The average rainfall distribution during the cotton production season is shown in Figure 1 (National Oceanic and Atmospheric Administration). The probability of rainfall becomes much greater in August and September and increased rainfall during this time often delays harvest which is detrimental to yield and quality (Figure 1). This condition also provides a prolonged availability of food for overwintering boll weevil which increases their number, resulting in heavier infestations the succeeding year. These infestations result in early initiation of an insecticide program, which in turn, destroys beneficial insects and spiders and virtually eliminates biological control of the bollworm and tobacco budworm. The cotton producer must use intensive insecticide applications, which generally continue until harvest. These more intensive insecticide applications further aggravate the tobacco budworm insecticide resistance problem (Sprott, et al.).

Short-Season Cotton

Continued widespread and heavy use of pesticides has led to the development of resistance by many insect pests. Concurrently, there have been significant adjustments in costs of agricultural inputs and prices of crops. Research in the past 5 to 7 years has led scientists of the U.S. Department of Agriculture, Texas Agricultural Experiment Station, and Texas Agricultural Extension Service, located at Weslaco, Texas, to develop an IPM program to more effectively control pest-insect infestations while maintaining cotton yields. This program basically a short-season cotton production system, using a semi-determinate variety, early planting, the use of field-scouting reports as a basis for deciding on need for insecticide use, and post-harvest crop residue destruction. The short-season production concept refers to early defoliation and early harvest, compared with production of conventional cotton varieties. The short-season production strategy results in an early fruit set and the growing season is reduced from 160 to 180 days under conventional techniques to 120 to 140 days. This reduction in the growing season helps offset the disadvantages associated with late-season insect infestations and undesirable weather as shown in Figure 1. Shortening the growing season, (by 20 days or more) through the use of early maturing varieties and appropriate management techniques, offers much potential for improving efficiencies in cotton production. IPM makes maximum use of the natural factors in the environment that regulate and limit pest population instead of relying on any one agent such as chemical pesticides. Artificial control measures should be used only at a level at which damage caused by the pest would be more costly than the control measures designed to prevent that damage.

Figure 1. Mean Monthly Precipitation Curve for the Lower Rio Grande Valley and Expected Dates of Planting, First-Bloom Defoliation, and Harvest for Determinate (Short-Season) and Nondeterminate (Conventional) Cotton Cultivars.

Study Area

This study will focus primarily on Cameron, Hidalgo, and Willacy counties in the LRGV of Texas. This region is characterized by a subtropical, semiarid climate with short, mild winters and long, hot summers. The growing season averages 330 days per year; average rainfall is 27 inches near the Gulf Coast and 19 inches in the southwestern portion of the valley. The high temperatures are about 100°F in July and August; January, the coldest month, has temperatures sometimes below freezing. The first freeze can be expected between December 6 and December 12. The last freeze can be expected generally between January 6 and January 28. These climatic conditions, plus the adequate irrigation systems in certain locations, result in a highly productive agriculture.

Of the total 1.7 million acres of cropland in the LRGV, 0.6 million acres are irrigated (*The Dallas Morning News*). Irrigation water is provided principally by irrigation districts with water diverted from the Rio Grande River. Land that is irrigated is linked to water district systems. Thus, irrigated acreage is reasonably stable.

Approximately 65 percent of the average annual 270,000 acres of cotton in the LRGV is produced by using irrigation. About 66 percent of the irrigated land and 85 percent of the dryland acres are light to medium textured soil types. Gerard, et al., found that on these light soils cotton yields are not always increased with irrigation. In fact, they reported that rainfall during the growing season in excess of 8-10 inches can cause significant yield reductions in irrigated cotton.

Farm input and production records were maintained from 1973-1978 on a total of 1003 fields of irrigated cotton and a total of 135 fields of dryland cotton, on light to medium textured soils. These fields were located near Harlingen, McAllen, Mission, Raymondville, and Weslaco, Texas. These fields were those which were included in the ongoing Texas Agricultural Extension Service Pest Management Program and included all varieties, management levels and both short-season and conventional cotton production practices. This analysis is not applicable to LRGV soils other than the light to medium textured ones.

Objectives

Economics is the key to the adoption of IPM strategies. It must increase the farmer's profit or he has no incentive to adjust from traditional crop production practices. The increase in profit to a producer due to use of IPM can be increased yield, reduced costs or a reduced yield where a cost reduction is greater than the value of the yield reduction. If rapid adoption of viable IPM programs is to be encouraged, it is critical that the economic implications be demonstrated to the producers (Lacewell).

The overall objective of this study is to evaluate alternative cotton production practices in the LRGV. The specific objectives are:

1. To statistically analyze the cotton lint yield implication between irrigated and dryland; short-season and conventional production strategies; producer management levels; and early, intermediate, and late maturing cotton varieties.
2. To statistically analyze insecticide application numbers and quantity of material used between short-season and conventional production techniques, with and without irrigation.
3. To develop breakeven prices and yields indicating relative advantages (disadvantages) of alternative cotton production strategies.
4. To compare expected net returns of short-season and conventional production techniques with and without irrigation.

Review of Literature

Due to rapidly increasing national fuel prices and other factors of production and accelerating insecticide resistance, scientists have become deeply interested in research related to developing new IPM cotton production systems. There are local, regional, statewide, and national IPM programs either in progress or being proposed.

The success of the short-season cotton production system is demonstrated by the very rapid complete adoption by producers throughout the Coastal Bend Region of Texas (nearly 300,000 acres of cotton). Within a 3-year period all cotton gins had to be modified for the stripper cotton where pickers had been used previously (Lacewell and Taylor, 1980). In 1979, the short-season optimal management cotton production system resulted in an $11 million increase in producer profits and an increase in regional economic activity of $94 million (Masud, et al.).

In the Wintergarden region (Sprott, et al.), the short-season production system is associated with a 50 percent yield increase while inputs are reduced 33 percent. Under IPM strategies, production costs per pound of lint were 13.8 cents less and the producer profit was increased from $12.40 per acre to $102.97 per acre.

Larson, et al., evaluating short-season cotton production under the new pest management program for the LRGV of Texas, found potential reduction in insecticide use by as much as 1,091,500 pounds (from 2,788,500 to 1,697,000 pounds) and increase in farmers' net returns by $4,330,200 (from $11,017,900 to $15,348,100), based on equal yield and quality for short-season and conventional cotton varieties. The study did not include any producer data and there is a need to establish validity of the estimates.

A recent study compared production between the short-season and conventional techniques on light soils in the LRGV (Collins, Lacewell, and Norman, 1979). Analysis of lint yields between the conventional and short-season production systems with irrigation, and for dryland indicated that only irrigated cotton grown by conventional techniques, was statistically different from all other yields. Insecticide use and number of applications were substantially higher for conventional production techniques for both dryland and irrigated production. The coefficient of variation indicated that relative variation of yield under a short-season production system, regardless of the water practice, was lower than yield of conventional cotton production. However, even with reduced input levels for short-season irrigated cotton production, the net returns favored conventional management by $21.97 per acre.

According to Collins, et al. (July 1979), dryland production best typifies the short-season techniques. By using only negligible levels of insecticides, dryland short-season production had the highest average per-acre net returns of all dryland and irrigated options ($126.31 per acre). The coefficient of variation on lint yields for dryland short-season cotton was slightly higher than for irrigated short-season cotton but the net returns were $116.79 per acre more for dryland. There are dramatic cost, energy, and pesticide implications associated with dryland short-season cotton produced in the LRGV (Collins, Lacewell, and Norman, 1979). This study was based on producer records for the 1973-75 period only. Implications for a more current time period are needed.

METHOD OF ANALYSIS

This study compares the impact of short-season cotton production under IPM strategies with conventional production, as it relates to yield and producer net returns in the LRGV of Texas. The analysis requires cotton production input data for both cotton production systems. These data provide the basis for conducting statistical tests and applying appropriate economic analysis.

Data Development

Data for the analysis were collected by scientists of the Texas Agricultural Extension Service, located at Weslaco, Texas in conjunction with their ongoing Texas cotton insect management program. The Texas cotton insect management program is a part of the beltwide cotton pest management demonstration and education program. The U.S. Department of Agriculture provided funds for this multi-state program. The Cooperative Extension Service for each participating state is responsible for implementing and conducting the program. The LRGV cotton insect management program was initiated during the 1972 production season.

Input and agronomic data were collected by county extension entomologists for each field of the producers participating in this program. Data included yield, planting date, cotton variety, water practice (dryland or irrigated), dates, and number of insecticide applications, pounds of insecticide material applied, and nitrogen use. Participating producer records for the period 1973-1978 were used in this study.

To evaluate the economic implications of alternative production practices, area producers were classified by short-season and conventional production practices. These production classifications were made by consulting with area agronomists and entomologists who are familiar with the production practices of farms used in this study.

Conventional production practice refers to producers who incorporated typical (high input) production techniques and conventional (long-season) cotton cultivars. Short-season production practice refers to those producers who incorporated production techniques based on higher plant populations, accelerated fruiting by limiting water and fertilizer applications and applying insecticide after scouting fields for economic threshold levels of insect infestations. If a producer incorporated the short-season (low input) production technique while planting conventional cotton cultivars, that producer was classified as using a short-season production practice.

Each producer was classified according to his management capabilities as subjectively evaluated by agronomists and entomologists who are familiar with these producers. Three management levels were used. Management levels 1, 2, and 3 were designated to producers with high, average, and poor management capabilities, respectively. Specific objectives were evaluated using (1) statistical analysis, (2) budgeting analysis, and (3) break-even analysis.

Statistical Analysis

Analysis of variance was used for the statistical analysis. The objective was to compare, statistically, the effect on mean yield, insecticide applications, and quantity of material used due to the following factors:

(1) the production practice used (i.e., short-season or conventional);

(2) the water practice incorporated (i.e., irrigated or dryland);

(3) the cotton variety planted;

(4) the cotton producer's managerial capability.

Statistical estimates were obtained for annual comparisons in addition to the two periods, 1973-75 and 1976-78, and across all years. The purpose here is to separate out the different groupings and also to see if there is any significant difference between 1973-75 and 1976-78, i.e., a hypothesis being that technology transfer was occurring so that the difference between short-season and conventional production practice was collapsing. Duncan's multiple-range test ($\alpha = 0.05$) was used to decide which differences were significant and which were not.

One objective of this study is to estimate the effect on producers' profit, from the adoption of IPM, over the 6-year period, 1973-78. Two components of profit are separately investigated: (1) change in yield, and (2) insecticide reduction. The risk factor of IPM is estimated and compared with the conventional cotton production practice.

IPM is an information (service) technology. Since information tends to reduce uncertainty and a major component of IPM is field scout reports for economic threshold levels of insect-pests, it is expected that the variation of yield is greater for producers using conventional practices than for producers using short-season practices.

One measure of relative variation is called the coefficient of variation and is defined as

$$CV = \frac{S}{\bar{X}}$$

where,

S is the standard deviation and $\bar{X}$ is the mean yield.

Budgeting Analysis

Per-acre crop enterprise budgets for irrigated and dryland cotton production with conventional and short-season practices were developed using partial budgeting techniques and modifying published cotton enterprise budgets for the LRGV. These budgets provided the base data for the analysis.

The data to modify the published crop budgets for the region between short-season and conventional practices for irrigated and dryland production included yields, insecticide application, quantity of insecticide material, number of irrigations, and fertilizer use. These data were available from the records of each field included in the study.

Budgets were built for the periods 1973-75 and 1976-78 to investigate the effect of price and cost changes on economic implications of the alternative cotton production practices over time. The prices of products and inputs were calculated for each period by averaging the prices received and paid during each of the 3 years in that period, as listed in the Texas Agricultural Extension Service budgets (Extension Economists-Management).

Based on the IPM strategy, the short-season production practice was budgeted for two irrigations as compared with three irrigations for conventional cotton production practice. Further, short-season producers were levied a charge for scouting their fields for economic threshold level of insect pests.

Breakeven Analysis

Using the crop enterprise budget data, the sensitivity of the alternative production practices to cotton prices and yields was determined through breakeven analysis. Breakeven analysis was used to estimate (1) the price of lint that would just cover variable costs of production and (2) the yields where net returns would be zero at a specified cotton price.

At the breakeven point, the revenue generated from the sale of the output just covers the total variable costs incurred in its production, i.e., TR = TVC.

Since $TR = P_y \cdot Y$ for a pure competitor,

$$P_y \cdot Y = TVC \text{ at the breakeven point}$$

where,

TR = total revenue,

TVC = total variable cost,

P_y = price per unit of output,

Y = output.

The breakeven price can be expressed as

$$P_y = \frac{TVC}{Y}$$

and the breakeven yield as

$$Y = \frac{TVC}{P_y}$$

The breakeven analysis is useful for indicating relative advantages of alternative cotton production practices.

Equations relating the breakeven net return conditions between two enterprises have been developed (Collins, et al., March 1979). In this study, breakeven yields and price of cotton will be estimated between alternative cotton production practices, i.e., conventional production practices compared to short-season production practices.

In general, the breakeven condition is satisfied by equation (1).

$$NR_i = NR_j \tag{1}$$

where

$i \neq j$,

NR_i = per-acre net returns associated with production practice i,

NR_j = per-acre net returns associated with production practice j.

The net returns, ignoring fixed costs, for a particular cotton production practice (production practice i) are defined as

$$NR_i = (P_i^L + r_iP_i^S - HC_i)\, Y_i^L - PHC_i \tag{2}$$

where

P_i^L = price of lint per unit of production practice i,

P_i^S = price of seed per unit of production practice i,

r_i = ratio of seed to lint yield for production practice i,

HC_i = harvest costs per unit of production practice i,

Y_i^L = lint yield per acre for production practice i,

PHC_i = variable preharvest costs, including defoliation per acre for production practice i.

By substituting equation (2) into equation (1) the breakeven condition is defined:

$$(P_i^L + r_iP_i^S - HC_i)\, Y_i^L - PHC_i = (P_j^L + r_jP_j^S - HC_j)\, Y_j^L - PHC_j. \tag{3}$$

Equation (3) can be solved for breakeven price (P_i^L) or yield (Y_i^L).

Solving for breakeven price, equation (3) becomes,

$$P_i^L = \frac{[(P_j^L + r_jP_j^S - HC_j)\, Y_j^L - PHC_j + PHC_i]}{Y_i^L} + HC_i - r_iP_i^S \tag{4}$$

where

P_i^L = price of cotton that would equate production practice i net returns with production practice j net returns.

Similarly, solving for breakeven yield, equation (3) becomes,

$$Y_i^L = \frac{[(P_j^L + r_jP_j^S - HC_j)\, Y_j^L - PHC_j + PHC_i]}{(P_i^L + r_iP_i^S - HC_i)}$$

where

Y_i^L = lint yield per acre for production practice i that would equate production practice i net returns with production practice j net returns.

The methods discussed above were applied to the basic grower data and enterprise budgets developed to estimate the economic implications of short-season cotton as compared to conventional cotton production.

PRODUCTION AND ECONOMIC IMPLICATIONS

There are many aspects to an appropriate analysis of a new crop production system, such as short-season cotton production in the LRGV of Texas. Of interest is yield, pesticide use, and farmer profit implications. However, an analysis is complicated by annual variations, management level, and irrigation practice. These results focus on a comparison of short-season cotton production and conventional cotton production in the LRGV over the period 1973-78. The two production practices are analyzed with respect to production and economic implications.

Production Implications

The basic objective herein is to compare yield between short-season and conventional cotton production. This is done in an aggregate sense for general implications. However, the comparison must be extended to consider also the effect of year, irrigation practice, variety, and management.

Aggregate Yield Effect

An illustration of an annual per-acre comparison of mean lint yields, coefficient of variation of yield, insecticide applications, and materials used between short-season and conventional cotton production practices for the period 1973-78 is presented in Figure 2 (see Appendix Table 1).

An evaluation of annual mean lint yields shows that short-season practice yields are statistically greater than conventional practice yields. Across all years, 1973-78, the mean yield of cotton lint grown by conventional practice is 442.2 lbs per acre, whereas the short-season practice yields 570.0 lbs per acre.

As expected, insecticide use and number of applications are substantially higher for the conventional practice. In the period 1973-78, an average of 19.9 lbs per acre of insecticide material were used in the 11.2 applications for the conventional cotton practice (approximately 1.75 lbs per acre per application). Only 7.4 lbs per acre insecticide were used in 7.5 applications on cotton associated with the short-season practice.

The coefficient of variation of yield indicates that across all years, the relative variation of short-season production is approximately 7 percent lower than that of conventional cotton production.

For the two periods, 1973-75 and 1976-78, analysis of the data for short-season versus conventional cotton production practice is summarized in Table 1. Analysis shows that only the lint yield of the short-season practice in 1976-78 is statistically different from all other yields. Even though there is no statistical difference, the conventional practice yield increases approximately 15 percent, from 431.5 lbs per acre in 1973-75 to 494.5 lbs per acre in the period 1976-78. Furthermore, the relative coefficient of variation of yield is much lower in the latter period, for both the conventional and short-season cotton production practices.

Water Practice Effect

In comparing the short-season and conventional cotton production practices, the effect of the water practice incorporated, i.e., irrigated or dryland, has been ignored. Because water is an important input in cotton production, an analysis of variance was computed on the rainfall records to form a basis for comparing dryland and irrigated cotton yields. Rainfall data for the months of September through November preceding the production seasons of 1973, 1974, 1975, 1976, 1977, and 1978 plus the rainfall amounts for the cotton growing season February through July were averaged by location. The analysis of variance showed no statistical difference in mean rainfall by area over the period, except for the production season of 1977, when it rained 13.48 inches during the growing season compared to the mean rainfall of approximately 9 inches. As mentioned earlier, Gerard, et al., reported that on light to medium textured soil types, rainfall in excess of 8-10 inches can cause significant yield reductions in irrigated cotton.

In the period 1973-75, the estimates of insecticide material used and number of applications for the conventional practice are statistically greater than the short-season practice. However, there is no statistical difference, in the 1976-78 estimates of insecticide use and applications, between the two production practices. This implies that the conventional cotton production system is evolving to the short-season system.

The dramatic reduction, over time, in pounds of insecticide material used and the number of applications for the conventional cotton production practice is illus-

TABLE 1. LINT YIELDS AND INSECTICIDE APPLICATIONS AND USE, OF SHORT-SEASON AND CONVENTIONAL PRODUCTION TECHNIQUES, LOWER RIO GRANDE VALLEY, FOR PERIODS 1973-1975 AND 1976-1978 IRRESPECTIVE OF WATER PRACTICE

		Lint Yield[a] (lbs/acre)	Coefficient of Variation of Yield (%)	Insecticide Applications[a] (no.)	Insecticide Use[a] (lbs)
1973-75	Conventional	431.5 (B)	46.6	11.7 (A)	21.8 (A)
	Short-Season	456.6 (B)	45.7	7.0 (B)	6.5 (B)
1976-78	Conventional	494.5 (B)	33.1	8.5 (B)	10.8 (B)
	Short-Season	643.5 (A)	28.0	7.9 (B)	8.0 (B)
1973-78	Conventional	442.2 (B)	43.8	11.2 (A)	19.9 (A)
	Short-Season	570.0 (A)	37.0	7.5 (B)	7.4 (B)

[a]Means with the same letter are not statistically different among all groups at the .05% level.

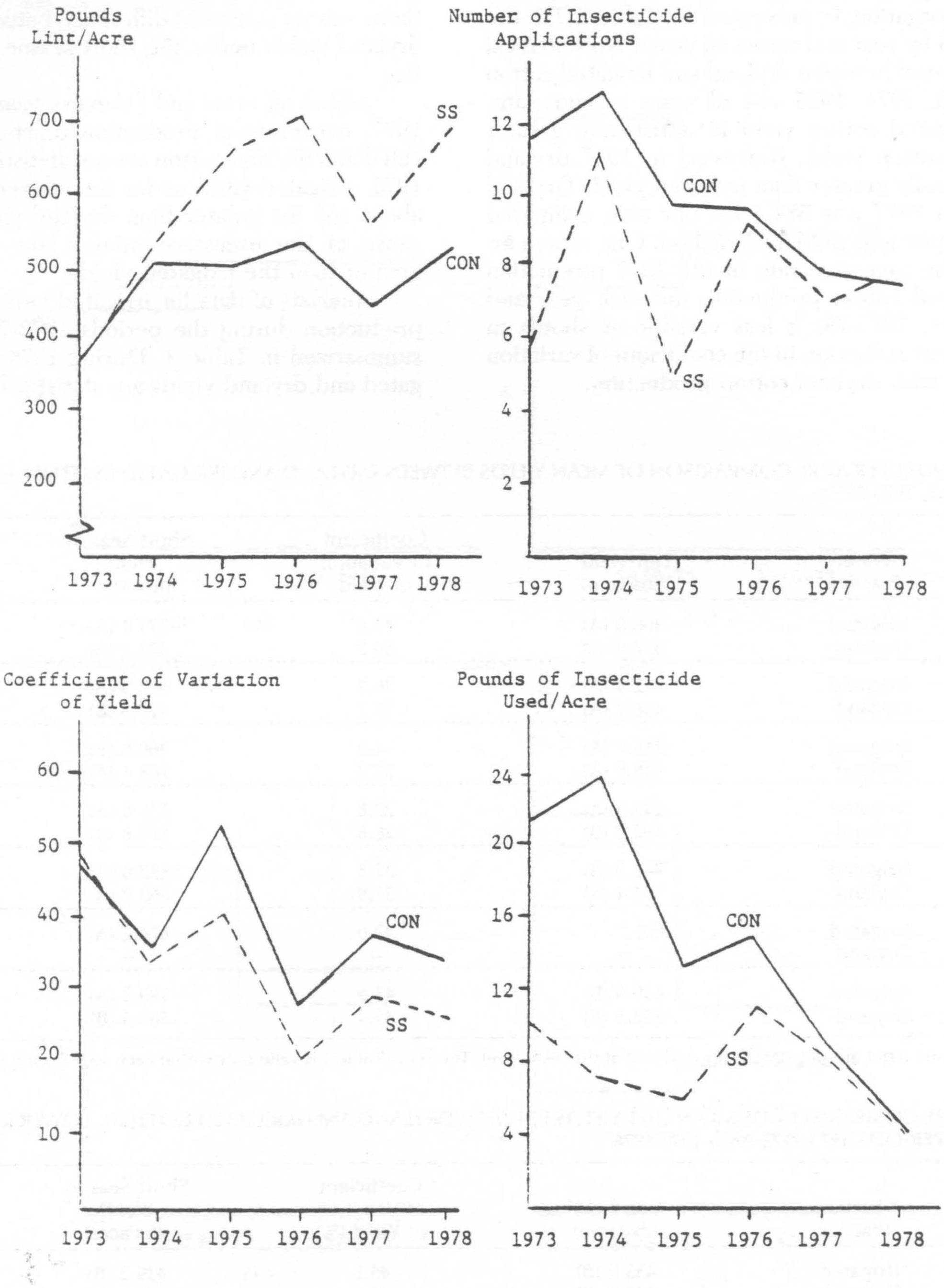

Figure 2. Annual Comparison of Short-Season and Conventional Cotton Production Practices.

trated in Figure 3, panels (c) and (d). Insecticide use declines almost 50 percent, from 21.8 lbs per acre in 1973-75 to 10.8 lbs per acre in 1976-78. For the short-season practice, there is a slight increase in quantity of insecticide used and number of applications during 1976-78, but these estimates are still lower than those for conventional production practices. This slight increase is reflective of increased boll weevil activity in these years.

An annual per-acre comparison of mean yields with and without irrigation is presented in Table 2 for the period 1973-78 by year and across all years. No statistical difference is found between dryland and irrigated cotton yields for 1973, 1974, 1975 and all years in aggregate. For 1976 irrigated cotton yield is statistically greater than dryland cotton yield. However, in 1977 dryland yield is statistically greater than irrigated yield. Dryland cotton yield in 1977 was 584.4 lbs per acre compared with 422.9 lbs per acre yield for irrigated. One reason for this may be the excessive rain in the 1977 production season. Irrigated cotton production for each year and across all years, 1973-78, is less variable as shown in about a 2 percent reduction in the coefficient of variation in comparison with dryland cotton production.

An annual comparison of the per-acre mean yields between dryland and irrigated cotton for both the sh[illegible]-season and conventional cotton production techniqu[illegible] also presented in Table 2 and illustrated in Figure 4. Across all years and for 1974 and 1976 irrigated cotton yields are statistically greater than dryland cotton yields, under the short-season production practice. Only the 1975 dryland yield of short-season cotton is statistically greater than irrigated cotton yield. In 1973 and 1977 there was no statistical difference between irrigated and dryland yields under the short-season production practice.

Across all years and for every year except 1975 and 1977, conventional production practice yields for irrigated and dryland cotton are not statistically different. In 1975, irrigated yield under the conventional practice is about 180 lbs greater than dryland yield. In 1977, because of the excessive rainfall, the dryland yield is greater than the irrigated yield.

Analysis of data for irrigated versus dryland cotton production during the periods 1973-75 and 1976-78 is summarized in Table 3. During 1976-78, both the irrigated and dryland yields are statistically greater than in

TABLE 2. AN ANNUAL PER ACRE COMPARISON OF MEAN YIELDS BETWEEN DRYLAND AND IRRIGATED COTTON, LOWER RIO GRANDE VALLEY OF TEXAS, 1973-78

Year	Water Practice	Lint Yield[a] (lbs/acre)	Coefficient of Variation of Yield	Short-Season Yield[a] (lbs/acre)	Conventional Yield[a] (lbs/acre)
1973	Irrigated	366.0 (A)	47.6	371.4 (A)	365.8 (A)
	Dryland	377.4 (A)	50.7	378.7 (A)	377.1 (A)
1974	Irrigated	502.3 (A)	36.2	520.9 (A)	501.4 (A)
	Dryland	458.2 (A)	37.7	427.8 (B)	478.9 (A)
1975	Irrigated	516.1 (A)	51.2	360.9 (B)	535.9 (A)
	Dryland	446.8 (A)	55.0	783.4 (A)	353.3 (B)
1976	Irrigated	593.9 (A)	22.8	731.9 (A)	541.4 (B)
	Dryland	492.0 (B)	28.8	548.8 (B)	460.4 (B)
1977	Irrigated	442.9 (B)	32.8	537.6 (A)	388.6 (B)
	Dryland	584.4 (A)	37.9	662.7 (A)	571.3 (A)
1978	Irrigated	605.7	32.0	674.2 (A)	519.4 (B)
	Dryland	--	--	--	--
1973-78	Irrigated	459.9 (B)	43.6	590.3 (A)	443.1 (B)
	Dryland	452.5 (B)	45.4	503.4 (B)	434.6 (B)

[a]Means with the same letter are not statistically different at the .05% level. The statistical test is valid only within each year among groups.

TABLE 3. PER ACRE COMPARISON OF MEAN LINT YIELDS BETWEEN DRYLAND AND IRRIGATED COTTON, LOWER RIO GRANDE VALLEY OF TEXAS, FOR PERIODS 1973-1975 AND 1976-1978

Period	Water Practice	Lint Yield[a] (lbs/acre)	Coefficient of Variation of Yield (%)	Short-Season Yield[a] (lbs/acre)	Conventional Yield[a] (lbs/acre)
1973-1975	Irrigated	435.0 (B)	45.6	439.2 (B)	434.8 (B)
	Dryland	419.2 (B)	48.0	477.3 (B)	397.7 (B)
1976-1978	Irrigated	546.8 (A)	33.6	648.5 (A)	486.9 (B)
	Dryland	547.4 (A)	34.6	591.5 (A)	534.4 (A[illegible]
1973-1978	Irrigated	459.9 (B)	43.6	590.3 (A)	443.1 ([illegible]
	Dryland	452.2 (B)	45.4	503.4 (B)	434.6 (B)

[a]Means with the same letter are not statistically different among all groups at the .05% level.

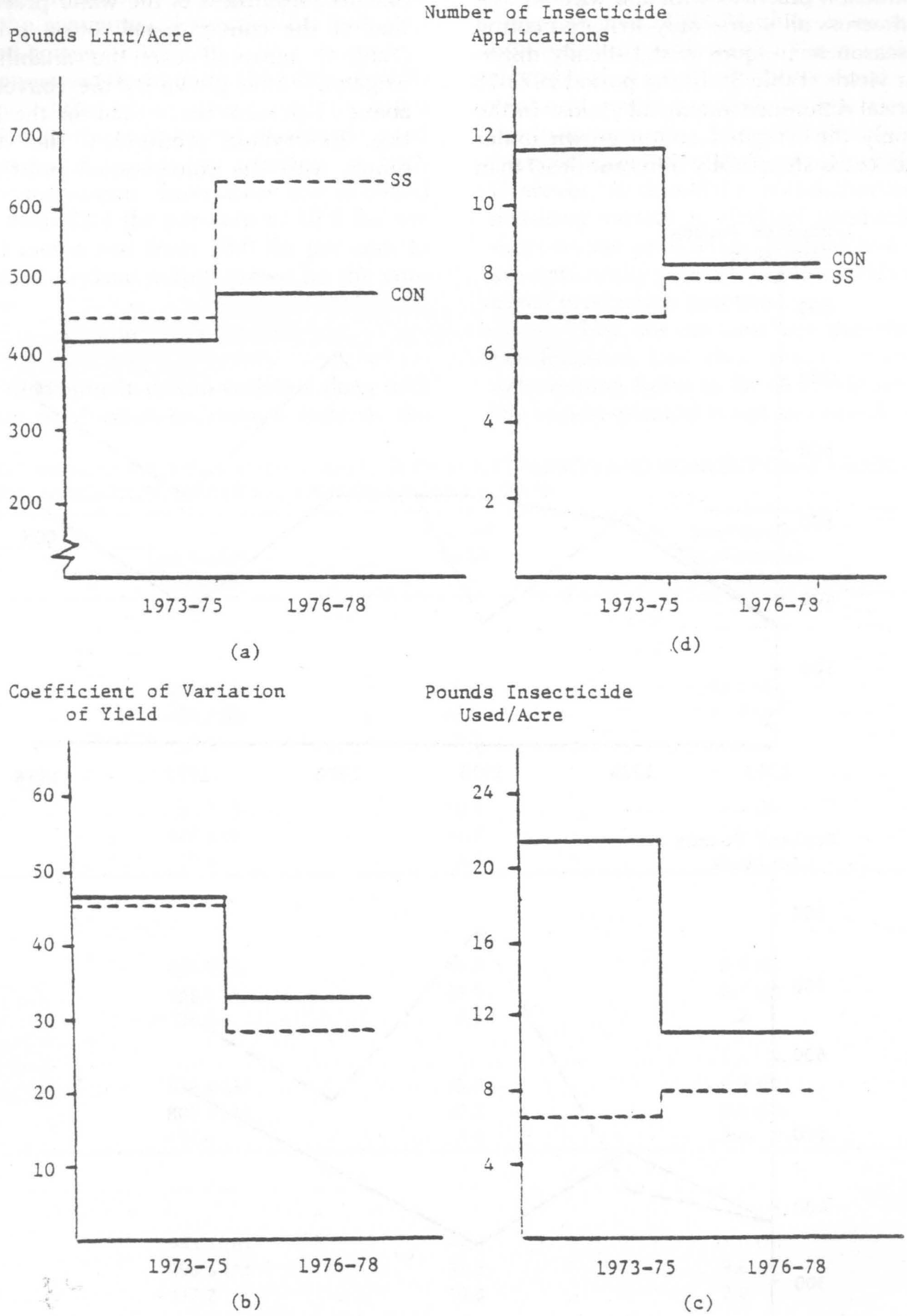

Figure 3. Comparison of Short-Season and Conventional Cotton Production Practices in the Lower Rio Grande Valley of Texas for Periods 1973-75 and 1976-78.

1973-75. However, across all years (1973-78) there is no statistical difference between the irrigated and dryland mean yields, which are 459.9 and 452.2 lbs per acre, respectively. Dryland cotton yield is approximately 2 percent more variable than irrigated yield across all years.

An evaluation of lint yield for short-season and conventional production practices with and without irrigation shows that across all years, only irrigated cotton grown by short-season techniques is statistically different from all other yields (Table 3). In the period 1973-75 there is no statistical difference among all yields. In the 1976-78 period only the irrigated cotton grown under conventional practices is statistically different (less) than all other years. However, the absolute yields (lint lbs per acre) under the short-season production practice, irrespective of water practice, are always greater than yields of cotton grown by the conventional practice.

The coefficient of variation of yield shows that the relative variation of the short-season cotton production practice, regardless of the water practice, is lower than that of the conventional cotton production practice (Table 4). Across all years, the variability of mean yield of irrigated cotton grown by the conventional practice is about 11 percent more than for the short-season practice. In dryland production, the variability of yield grown with the conventional practice is 6.4 percent

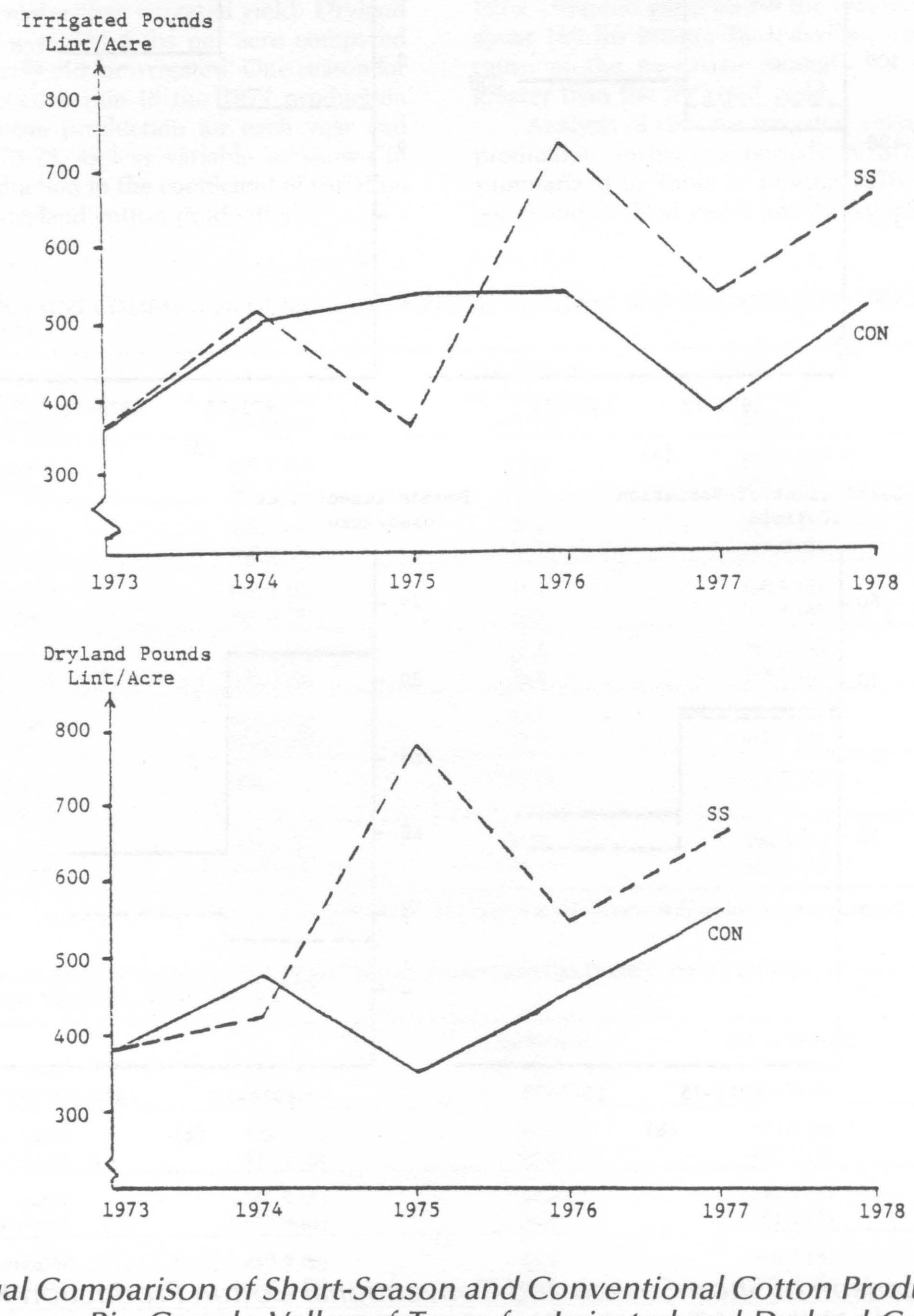

Figure 4. Annual Comparison of Short-Season and Conventional Cotton Production Practice Yields in the Lower Rio Grande Valley of Texas for Irrigated and Dryland Cotton.

greater than for the short-season practice.

Estimates for the number of insecticide applications and quantity of insecticide material used are presented in Table 4. Across the whole period, 1973-78, 11 and 13.3 lbs per acre more insecticide material was used for irrigated and dryland production respectively, under the conventional practice as compared with the short-season practice. Also, the number of insecticide applications was greater for the conventional practice for both irrigated and dryland cotton.

However, comparing the periods 1973-75 and 1976-78, it should be noted that in the latter period, there is a dramatic reduction in the quantity of insecticide used under the conventional production practice, in both irrigated and dryland cotton. Insecticide use declined over 50 percent from 22.4 lbs per acre to 10.9 lbs per acre, in irrigated cotton and from 15.0 lbs per acre to 10.1 lbs per acre, in dryland cotton grown by the conventional practice.

Variety Effect

Use of semi-determinate cotton varieties along with other short-season production techniques reduces the growing season by 20 to 30 days, thereby offsetting the disadvantages associated with late-season insect infestations and undesirable weather conditions. In this section, the effect on yield due to the cotton variety planted under both short-season and conventional production practices, with and without irrigation is analyzed.

The mean yields of early, intermediate, and late maturing cotton varieties are presented in Table 5. Across all years 1973-78, there is no statistical difference between the yields of the three varieties for irrigated short-season, irrigated conventional, and dryland conventional practices. Only in the short-season dryland production practice, the yield of variety 3 (late maturing) is statistically different (less) among the three varieties. However, it should be noted that except for the late maturing variety in dryland production, the yields of short-season production, irrespective of water practice, are statistically greater than the yields under the conventional production practice.

Thus, we can conclude that the production practice followed, i.e., short-season or conventional, is the determining factor as far as yields are concerned, while the variety planted is not so critical.

TABLE 4. LINT YIELDS, INSECTICIDE APPLICATIONS, AND USE OF SHORT-SEASON AND CONVENTIONAL PRODUCTION TECHNIQUES WITH AND WITHOUT IRRIGATION, LOWER RIO GRANDE VALLEY OF TEXAS

	Lint Yield[a] (lbs/acre)	C.V. of[b] Yield (%)	Insecticide[a] Applications (no.)	Insecticide[a] Use (lbs)
1973-75				
Irrigated:				
Conventional	434.8 (B)	46.0	12.1 (A)	22.4 (A)
Short-Season	439.2 (B)	43.5	11.9 (A)	11.7 (B)
Difference	−4.4	2.2	.2	10.7
Dryland:				
Conventional	397.7 (B)	50.1	7.5 (B)	15.0 (A)
Short-Season	477.3 (B)	41.7	1.0 (C)	0.3 (C)
Difference	−79.6	8.4	6.5	14.7
1976-1978				
Irrigated:				
Conventional	486.9 (B)	34.2	8.9 (B)	10.9 (B)
Short-Season	648.5 (A)	25.6	8.7 (B)	8.8 (B)
Difference	−151.6	8.6	.2	2.1
Dryland:				
Conventional	534.4 (A)	35.7	6.2 (B)	10.1 (B)
Short-Season	591.5 (A)	32.3	0.6 (C)	0.5 (C)
Difference	−57.1	3.4	5.6	9.6
1973-1978				
Irrigated:				
Conventional	443.1 (B)	44.0	11.6 (A)	20.6 (A)
Short-Season	590.3 (A)	33.2	9.6 (A)	9.6 (B)
Difference	−147.2	10.8	2.0	11.0
Dryland:				
Conventional	434.6 (B)	46.9	7.2 (B)	13.7 (A)
Short-Season	503.4 (B)	40.5	0.9 (C)	0.4 (C)
Difference	−69.2	6.4	6.3	13.3

[a]Means with the same letter are not statistically different among all groups at the .05% level.
[b]C.V. stands for the coefficient of variation statistic.

TABLE 5. COMPARISONS OF MEAN YIELDS OF DIFFERENT COTTON VARIETIES, LOWER RIO GRANDE VALLEY OF TEXAS

Variety[a]	Irrigated Lint Yield[b] SS[c]	Irrigated Lint Yield[b] CON[c]	Dryland Lint Yield[b] SS[c]	Dryland Lint Yield[b] CON[c]
	(lbs/acre)			
	1973-1975			
1	538.6 (A)	475.8 (B)	---	420.0 (B)
2	---	391.6 (B)	865.8 (A)	---
3	656.8 (A)	436.2 (B)	363.0 (B)	389.2 (B)
	1976-1978			
1	681.1 (A)	461.2 (B)	744.0 (A)	---
2	638.3 (A)	459.5 (B)	540.7 (A)	---
3	591.3 (A)	508.3 (B)	---	534.4 (A)
	1973-1978			
1	594.8 (A)	475.7 (B)	744.0 (A)	420.0 (B)
2	638.3 (A)	409.0 (B)	671.1 (A)	---
3	609.6 (A)	444.0 (B)	363.0 (B)	456.6 (B)

[a]Variety 1, 2, and 3 correspond to early, inermediate, and late maturing cotton cultivars respectively.
[b]Means with the same letter are not statistically different among all groups at the .05% level.
[c]SS and CON refer to production practice irregardless of variety, and SS is short-season production practice and CON is conventional production practice.

TABLE 6. COMPARISONS OF MEAN YIELDS OF DIFFERENT MANAGEMENT LEVELS FOR COTTON PRODUCTION, LOWER RIO GRANDE VALLEY OF TEXAS

Management Level[a]	Irrigated Lint Yield[b] SS[c]	Irrigated Lint Yield[b] CON[c]	Dryland Lint Yield[b] SS[c]	Dryland Lint Yield[b] CON[c]
	(lbs/acre)			
	1973-1975			
1	1340.0 (A)	597.1 (A)		
2	---	482.7 (B)	489.7 (B)	455.8 (B)
3	410.1 (B)	402.0 (B)	442.3 (B)	331.2 (B)
	1976-1978			
1	787.6 (A)	602.7 (A)	744.0 (A)	---
2	570.1 (A)	540.0 (A)	540.7 (A)	626.6 (A)
3	612.0 (A)	455.5 (B)	---	513.4 (B)
	1973-1978			
1	808.1 (A)	597.7 (A)	744.0 (A)	---
2	570.1 (A)	494.2 (B)	495.6 (B)	475.2 (B)
3	489.6 (B)	414.6 (B)	442.3 (B)	402.8 (B)

[a]Management levels 1, 2, and 3 refer to producers with high, average, and poor management capabilities, respectively.
[b]Means with the same letter are not statistically different among all groups at the .05% level.
[c]SS and CON refer to production practice irregardless of variety, and SS is short-season production practice and CON is conventional production practice.

Management Effect

Each producer participating in this study was classified according to his management capabilities as subjectively evaluated by agronomists and entomologists who are familiar with these producers. Management levels 1, 2, and 3 are designated to producers with high, average, and poor management capabilities, respectively.

The effect on yield due to the management levels for short-season and conventional production practice, with and without irrigation, is presented in Table 6.

In the period 1973-75, only the yields of irrigated cotton for both short-season and conventional practice, associated with management level 1 are statistically different from all other yields. However, the short-season yields, irrespective of water practice, are greater than conventional practice yields for each management level.

In the period 1976-78, only the conventional yields of management 3, for both irrigated and dryland cotton, are statistically different (less) than all other yields.

Across all years, 1973-78, short-season yields are greater than the yields of conventional practice, for both irrigated and dryland cotton production. Yields of management level 1 for all production options and management level 2 for irrigated short-season cotton are statistically different (greater) than all other yields. Irrespective of the production option, management levels 1, 2, and 3 indicate a declining yield level which implies a declining managerial ability.

Economic Implications

The previous section provides data that indicate a yield advantage for the short-season cotton production practices compared to conventional production practices. However, a critical issue is the effect on costs and returns of producers and what economic incentive exists for cotton farmers. The economic analysis considers per-acre profit for the different production systems over the two periods 1973-75 and 1976-78. This is followed by sensitivity analysis in the form of breakeven yields and prices.

Per-Acre Net Returns

Crop enterprise budgets were built for the two periods, 1973-75 and 1976-78 to investigate the effect of price and cost changes on economic implications of the alternative production practices over time. Budgets of short-season and conventional production practices are presented in Appendix Tables 2 through 9.

A per-acre comparison of net returns between short-season and conventional cotton production practices, with and without irrigation, is presented in Table 7, for the two periods 1973-75 and 1976-78. First, net returns by production and irrigation practice are computed by considering only the variable costs (Table 7).

Results indicate that dryland cotton production, for both short-season and conventional practice, is more profitable than irrigated cotton production. Returns above variable costs associated with the short-season cotton production practice, with and without irrigation, are greater than expected net returns under the conventional production practice. The results indicate that dryland short-season cotton production is the most profitable cotton production strategy, with estimated per-acre net returns of \$154.08 and \$190.48, for 1973-75 a[illegible] 1976-78, respectively.

Comparing the two periods, only the net returns associated with the conventional irrigated cotton production practice declined from 1973-75 to 1976-78. Returns above variable costs for the short-season irrigated cotton production practice improved the most over the two periods, increasing by $62.50, from $61.42 per acre in 1973-75 and $123.92 per acre in 1976-78.

Comparing the returns per acre above total costs (Table 7), the results indicate that dryland short-season production has the highest net returns of all production options, $93.42 per acre in 1973-75 and $117.31 per acre in 1976-78. Again, the conventional practice with irrigation is associated with the lowest net returns. In fact, the irrigated conventional cotton production practice incurs net losses of $34.78 per acre and $65.64 per acre, in 1973-75 and 1976-78 respectively.

It is re-emphasized that these data refer to the light to medium textured soils of the LRGV. Also, year to year variations are critical, thus, an analysis over several years may reveal that irrigating cotton is not profitable in aggregate but for a specific year it may very well be the most profitable alternative. These economic indications provide general directions, but there are many specific and unique situations which must be considered.

TABLE 7. COMPARISON OF PER-ACRE NET RETURNS FOR ALTERNATIVE COTTON PRODUCTION OPTIONS, LOWER RIO GRANDE VALLEY OF TEXAS

	Irrigated		Dryland	
Period	SS[a]	CON[a]	SS[a]	CON[a]
	(dollars)			
	Returns Above Variable Costs			
1973-75	61.42	48.88	154.08	96.39
1976-78	123.92	29.93	190.48	141.23
	Returns Above Total Costs			
1973-75	−22.24	−34.78	93.42	35.73
1976-78	28.35	−65.64	117.31	68.06

[a]SS and CON refer to production practice irregardless of variety, and SS is short-season production practice and CON is conventional production practice.

Breakeven Analysis

The economic analysis was extended to include estimating a breakeven yield and a breakeven price between the alternative cotton production practices. The per-acre net returns for each alternative cotton production strategy was calculated by deducting total variable costs from gross receipts. The per-acre net returns, for the two periods 1973-75 and 1976-78, are presented in Table 7.

Breakeven Yields

A comparison of breakeven yields for the alternative cotton production practices in relation to expected or base yields of these practices is presented in Table 8 and 9, for the periods 1973-75 and 1976-78. The breakeven yield of one production practice in relation to the expected base yield of another production practice, represents the yield where per-acre net returns are equal for both practices, with a given cotton lint price. For example, in the period 1973-75 (Table 8), for a 439 lbs per acre base yield of short-season irrigated cotton, and the cotton lint

TABLE 8. BREAKEVEN COTTON YIELDS OF SHORT-SEASON AND CONVENTIONAL PRODUCTION PRACTICES FOR IRRIGATED AND DRYLAND, 1973-75, LOWER RIO GRANDE VALLEY OF TEXAS[a]

Base for Comparison			Breakeven Lint Yield by Specified Practice[b]			
Production Practice[c]	Lint Yield lbs/acre	Price $/lb	SS (Irr)	CON (Irr)	SS (Dry)	CON (Dry)
			(lbs/acre)			
SS (Irr)	439.0	.45	439.0	465.7	260.3	315.5
CON (Irr)	435.0	.45	408.3	435.0	230.2	284.9
SS (Dry)	477.0	.45	659.8	686.6	477.0	536.1
CON (Dry)	398.0	.45	521.6	548.3	341.3	398.0

[a]The analysis assumes a price of $95.00 per ton of cottonseed.
[b]Yield required for the production practice listed that equates net returns to the base identified in the first three columns to the left.
[c]SS and CON refer to production practice irregardless of variety, and SS is short-season production practice and CON is conventional production practice. Irr refers to cotton grown with irrigation and Dry is cotton grown without irrigation.

TABLE 9. BREAKEVEN COTTON YIELDS OF SHORT-SEASON AND CONVENTIONAL PRODUCTION PRACTICES FOR IRRIGATED AND DRYLAND, 1976-78, LOWER RIO GRANDE VALLEY OF TEXAS[a]

Base of Comparison			Breakeven Lint Yield by Specified Practice[b]			
Production Practice[c]	Lint Yield lbs/acre	Price $/lb	SS (Irr)	CON (Irr)	SS (Dry)	CON (Dry)
			(lbs/acre)			
SS (Irr)	649.0	.51	649.0	702.9	443.7	495.7
CON (Irr)	487.0	.51	439.9	487.0	236.0	285.6
SS (Dry)	592.0	.51	798.0	856.4	592.0	645.5
CON (Dry)	534.0	.51	687.1	742.2	481.6	534.0

[a]The analysis assumes a price of $80.00 per ton of cottonseed.
[b]Yield required for the production practice listed that equates net returns to the base identified in the first three columns to the left.
[c]SS and CON refer to production practice irregardless of variety, and SS is short-season production practice and CON is conventional production practice. Irr refers to cotton grown with irrigation and Dry is cotton grown without irrigation.

price of $0.45 per lb, the conventional irrigated cotton practice would need a lint yield of 465.7 lbs per acre to maintain a breakeven relationship with the short-season irrigated cotton production practice. Similar interpretations can be made for all other breakeven yield relationships. Thus, the short-season dryland practice would need a lint yield of only 230.3 lbs per acre (compared with its base yield of 477.0 lbs per acre) to maintain a breakeven relationship with conventional irrigated cotton practice with a base yield of 435 lbs per acre, and cotton lint price of $.45 per lb (Table 8). Short-season dryland cotton had the least breakeven yield of all cotton production options in the period 1973-75. Both dryland options would need to yield well below their average estimated yields to maintain a breakeven relationship with the irrigated options.

For the period 1976-78, the conventional irrigated cotton practice would need to yield significantly above its estimated base yield of 487 lbs per acre to maintain a breakeven relationship with all other options. Again, short-season dryland cotton had the lowest breakeven yield of all cotton production options. Short-season irrigated cotton would need to yield only 439.9 lbs per acre (which is well below the expected base yield of 649 lbs per acre) to maintain a breakeven relationship with the conventional irrigated cotton practice.

The implication is that the short-season dryland cotton production practice could produce well below its average yield and still have per-acre net returns comparable to all other cotton production alternatives.

Breakeven Prices

The breakeven price relationship between short season and conventional production practices, with and without irrigation are presented in Tables 10 and 11.

During the period 1973-75, breakeven price relationships between all production options indicates that short-season dryland cotton production has an absolute advantage over all other options. For example, with the cotton lint price of $.45/lb, and an estimated base yield of 477 lbs per acre for short-season dryland practice, a lint price of $.60/lb for conventional dryland cotton would be needed to maintain a net return breakeven relationship.

During the period 1976-78, analysis of breakeven price relationships among all cotton production strategies indicates that conventional irrigated cotton practice has the greatest absolute disadvantage. With the cotton lint price of $.51/lb, and an estimated base yield of 487 lbs per acre for conventional irrigated cotton, lint prices of $.37 per lb for short-season irrigated, $.24 per lb for short-season dryland cotton and $.30 per lb for conventional dryland practice would maintain a net return breakeven relationship. Again, short-season dryland production has an absolute advantage over all other options. These data indicate that even if the short-season cotton production practice under dryland has some quality loss, there can be a large price decline for the cotton produced with the short-season system and it will still produce a net return comparable to the conventional production practice.

TABLE 10. BREAKEVEN COTTON PRICES OF SHORT-SEASON AND CONVENTIONAL PRODUCTION PRACTICES FOR IRRIGATED AND DRYLAND, 1973-75, LOWER RIO GRANDE VALLEY OF TEXAS[a]

Base for Comparison			Breakeven Price by Specified Practice[b]			
Production Practice[c]	Lint Yield lbs/acre	Price $/lb	SS (Irr)	CON (Irr)	SS (Dry)	CON (Dry)
			($/lb)			
SS (Irr)	439.0	.45	.45	.48	.26	.36
CON (Irr)	435.0	.45	.42	.45	.23	.33
SS (Dry)	477.0	.45	.66	.69	.45	.60
CON (Dry)	398.0	.45	.53	.56	.33	.45

[a]The analysis assumes a price of $95.00 per ton of cottonseed.

[b]Price required for the production practice listed that equates net returns to the base identified in the first three columns to the left.

[c]SS and CON refer to production practice irregardless of variety, and SS is short-season production practice and CON is conventional production practice. Irr refers to cotton grown with irrigation and Dry is cotton grown without irrigation.

TABLE 11. BREAKEVEN COTTON PRICES OF SHORT-SEASON AND CONVENTIONAL PRODUCTION PRACTICES FOR IRRIGATED AND DRYLAND, 1976-78, LOWER RIO GRANDE VALLEY OF TEXAS[a]

Base for Comparison			Breakeven Price by Specified Practice[b]			
Production Practice[c]	Lint Yield lbs/acre	Price $/lb	SS (Irr)	CON (Irr)	SS (Dry)	CON (Dry)
			($/lb)			
SS (Irr)	649.0	.51	.51	.70	.40	.48
CON (Irr)	487.0	.51	.37	.51	.24	.30
SS (Dry)	592.0	.51	.61	.84	.51	.60
CON (Dry)	534.0	.51	.54	.74	.43	.51

[a]The analysis assumes a price of $80.00 per ton of cottonseed.

[b]Price required for the production practice listed that equates net returns to the base identified in the first three columns to the left.

[c]SS and CON refer to production practice irregardless of variety, and SS is short-season production practice and CON is conventional production practice. Irr refers to cotton grown with irrigation and Dry is cotton grown without irrigation.

Conclusions

The incidence of pest populations and development of resistance to insecticides in the LRGV have caused concern about levels of insecticide use and costs of production for cotton. Conventional cotton production practices prolong crop maturation and thus delay harvesting until late August or early September. These factors affect yield, costs, risk, quality of lint, and farmer profit (Gerard, et al., 1977; Larson, et al., 1975).

In an effort to gain effective control of insect pest infestations and maintain per-acre yields, an IPM strategy that encompasses short-season production practices has been incorporated by several LRGV producers in recent years. The IPM strategy switches production from an indeterminate (conventional) cotton cultivar to a semi-determinate (short-season) cotton cultivar, incorporates certain cultural techniques, and uses field scouting for deciding on need of insecticide application. Short-season production results in an early fruit-set and a reduction in the growing season by 20 days or more and enables cotton producers to circumvent the disadvantages associated with late-season insect infestations and undesirable weather.

The cotton producer is concerned about profit and risk. If the new IPM program increases profits and/or reduces risk, the cotton producers have an opportunity to improve their economic condition. Two major components of profit are yield and insecticide expenditures. The results support the conclusion that by shifting to a short-season practice from the conventional practice (a) there is a significant reduction in insecticide use, (b) the mean lint yield is increased and (c) risk, as measured by the coefficient of variation of yield, would decrease. Thus, with the short-season cotton production practice, net returns would be higher than with conventional practice. This economic incentive should induce more growers to transfer to the short-season (IPM) strategy.

Analysis of the data, 1973-78, for cotton production with and without irrigation in the LRGV indicates that dryland production is more profitable than irrigated cotton for both short-season and conventional practices. Average net returns above variable production costs are highest with the short-season dryland cotton production practice. This outcome is primarily due to reduced levels of irrigation, insecticide use, and insecticide applications. The implications of the study are that if one strategy is to be followed over several years, then the dryland short-season practice is clearly advantageous. However, there may be specific years, when subsoil moisture normally created by fall rains and subsequent spring rainfall is inadequate, where it would be more profitable to irrigate under the short-season production strategy.

Secondary benefits of the short-season cotton production system in the LRGV include a more consistent lint quality since the cotton is harvested before August. August rainfall often delays harvest, reduces the quality of the lint and aggravates the overwintering boll weevil problem when the conventional cotton production practices are incorporated. With the short-season cotton harvested before August, the stalks can be destroyed earlier. Eventually, as more producers incorporate the short-season practice, there would be a reduction in overwintering boll weevils and more effective biological control of bollworms and budworms due to the expected reduction of insecticide treatments for boll weevil control. This suggests that less insecticide would be introduced into the environment and costs of cotton production in the LRGV would be lower. Short-season cotton production practices in the LRGV of Texas appears promising as a viable system and an improvement over the conventional cotton production practice.

Limitations of the Study

Although there is evidence supporting the short-season production practice, it is important to emphasize the shortcomings and limitations of the present analysis. First, the data in this study refer to light to medium textured soils only. Other soil types may be more conducive to irrigated cotton production. There is need to reflect yield differences and associated harvesting cost differences among soil types. Year-to-year variations are critical. Analysis over several years may reveal that irrigating cotton is not profitable in aggregate, but for a specific year it may very well be the most profitable alternative. The economic indications in this study provide general direction, but there are many specific and unique situations which must be considered. This study lacks explicit consideration of quality of lint associated with the short-season versus conventional cotton production practice. Additional work is needed on ranges of quality between the alternate production practices.

A final caution is emphasized. The 6 years considered in this analysis may not have been typical with regard to insect-pest problems. The quantity of insecticide applied under the short-season production practice may be underestimated, while the yield may be overestimated. However, professionals associated with cotton production in the LRGV are confident that the directions are correct, i.e., time should prove the short-season cotton production practice will be associated with less insecticide use and greater yields as compared to conventional cotton production practices.

REFERENCES

Carlson, Gerald A. "A Decision Theoretic Approach to Crop Disease Prediction and Control." *American Journal of Agricultural Economics*, 52(1970): 216-223.

Collins, G. S., R. D. Lacewell and M. D. Heilman. "An Economic Comparison of Corn and Grain Sorghum Production: Texas Lower Rio Grande Valley." Texas Agricultural Experiment Station MP-1403, March 1979.

Collins, G. S., R. D. Lacewell and J. Norman. "Economic Implications of Alternative Cotton Production Practices: Texas Lower Rio Grande Valley." *Southern Journal of Agricultural Economics*, Vol. 11, No. 1, July 1979.

Dallas Morning News, The. "Texas Almanac." A. H. Bale Corporation, 1977-78.

Extension Economists-Management. "Texas Crop Budgets." Texas Agricultural Extension Service MP-1027, 1979.

Frisbie, Ray, Roy Parker, Roger Bradshaw, Bill Buxkemper, Bill Bagley, and John Norman. "Texas Pest Management Annual Report, 1973." Texas Agricultural Extension Service, 1973.

Gerard, C. J., B. W. Hipp, and S. A. Reeves. "Yields, Growth, and Management Requirements of Selected Crops as Influenced by Soil Properties." Texas Agricultural Experiment Station B-1173, pp. 6-7, January 1977.

Hall, Darwin C. and Richard B. Norgard. "On the Timing and Application of Pesticides." *American Journal of Agricultural Economics*, 55(1973): 198-201.

Heady, Earl O. *Economics of Agricultural Production and Resource Use*. Englewood Cliffs, New Jersey: Prentice Hall, 1965.

Lacewell, Ronald D. "Economic and Energy Implications of Integrated Pest Management." Mimeograph, September 1978.

Lacewell, Ronald D. and C. R. Taylor. "Economic Analysis of Cotton Pest Management Programs." Texas A&M University, Department of Agricultural Economics TA-15972, 1980.

Larson, J. L., R. D. Lacewell, J. E. Casey, L. N. Namken, M. D. Heilman, and R. D. Parker. "Impact of Short-Season Cotton Production on Producer Returns, Insecticide Use, and Energy Consumption — Lower Rio Grande Valley of Texas." Texas Agricultural Experiment Station MP-1204, June 1975.

Masud, Sharif M., Ronald D. Lacewell, C. Robert Taylor, John H. Benedict, and Lawrence A. Lippke. "An Economic Analysis of Integrated Pest Management Strategies for Cotton Production in the Coastal Bend Region of Texas." Texas Agricultural Experiment Station MP-1467, 1980.

Namken, L. N. and M. D. Heilman. "Determinate Cotton Cultivars for More Efficient Cotton Production in the Lower Rio Grande Valley." *Agronomy Journal*, 65(1973): 953-956.

National Oceanic and Atmospheric Administration. "Climatological Data: Texas." Environmental Data Service, National Climatic Center, Asheville, North Carolina, 1972-1978.

Norman, John. Entomologist, Texas Agricultural Extension Service, Weslaco, Texas. Personal communication, July 1979.

Pimentel, D., L. D. Hurd, A. C. Belloti, M. J. Forester, I. M. Oka, O. D. Sholes, and R. J. Whitman. "Food Production and the Energy Crisis." *Sciences*, 182(1973): 443-449.

Sprott, J. M., R. D. Lacewell, G. A. Niles, J. R. Walker, and J. R. Gannaway. "Agronomic, Economic, Energy, and Environmental Implications of Short-Season, Narrow-Row Cotton Production." Texas Agricultural Experiment Station MP-1250C, February 1976.

Texas Agricultural Extension Service. "Management of Cotton Insects in the Lower Rio Grande Valley of Texas." Texas Agricultural Extension Service B-1210, May 1979.

Texas Crop and Livestock Reporting Service. "Texas Cotton Statistics." U.S. Depatment of Agriculture, 1970 to 1978 issues.

Texas Crop and Livestock Reporting Service. "Texas Field Crops Statistics." U.S. Department of Agriculture, 1970 to 1978 issues.

Texas Crop and Livestock Reporting Service. "Texas Prices Received and Paid by Farmers." U.S. Department of Agriculture, 1971 to 1979 issues.

APPENDIX

BUDGETS OF SHORT-SEASON AND CONVENTIONAL PRODUCTION PRACTICES OF COTTON IN THE LOWER RIO GRANDE VALLEY OF TEXAS

APPENDIX TABLE 1. AN ANNUAL PER ACRE COMPARISON OF MEAN LINT YIELDS AND INSECTICIDE APPLICATIONS AND USE, BETWEEN SHORT-SEASON AND CONVENTIONAL PRODUCTION PRACTICES, LOWER RIO GRANDE VALLEY OF TEXAS, 1973-78

Year	System	Lint Yield[b] (lbs/acre)	Coefficient of Variation of Yield (%)	Insecticide[b] Application	Insecticide[b] Pounds
1973	CON	367.2 (A)	47.9	11.4 (A)	21.1 (A)
	SS	363.0 (A)	48.5	5.3 (B)	10.1 (B)
1974	CON	501.7 (A)	36.2	12.6 (A)	23.7 (A)
	SS	507.4 (A)	35.8	11.0 (A)	6.9 (B)
1975	CON	495.2 (B)	53.3	9.6 (A)	13.1 (A)
	SS	647.4 (A)	40.7	4.9 (B)	6.0 (B)
1976	CON	532.3 (B)	27.9	9.5 (A)	14.7 (A)
	SS	703.3 (A)	21.2	9.3 (A)	11.5 (B)
1977	CON	439.2 (B)	38.1	7.7 (A)	8.5 (A)
	SS	550.1 (A)	30.4	6.8 (A)	8.1 (A)
1978	CON	519.4 (B)	34.5	7.6 (A)	4.3 (A)
	SS	647.2 (A)	26.6	7.3 (A)	3.7 (A)
1973-78	CON	442.2 (B)	43.8	11.2 (A)	19.9 (A)
	SS	570.0 (A)	37.0	7.5 (B)	7.4 (B)

[a]CON refers to the conventional cotton production system and SS to the short-season system.
[b]Means with the same letter are not statistically different at the .05% level. The statistical test is valid only within each year among groups.

APPENDIX TABLE 2. IRRIGATED COTTON, ESTIMATED COSTS, AND RETURNS PER ACRE, SHORT-SEASON MANAGEMENT, LOWER RIO GRANDE VALLEY, TEXAS, 1973-75

	Unit	Price or Cost/Unit	Quantity	Value or Cost
1. Gross Receipts from Production:				
Cotton Lint	lbs	$ .45	439.00	$197.55
Cotton Seed	ton	95.00	.35	33.25
Total				$230.80
2. Variable Costs:				
Preharvest				
Seed	lbs	$ .30	20.00	$ 6.00
Fert. (60-40-0)	acre	20.00	1.00	20.00
Herbicide	acre	6.06	1.00	6.06
Insecticide	acre	19.88	1.00	19.88
Custom Spray	appl	1.38	12.00	16.56
Field Scouting	acre	2.00	1.00	2.00
Water Charge	appl	3.00	2.00	6.00
Machinery	acre	5.79	1.00	5.79
Tractors	acre	12.63	1.00	12.63
Irrigation Machinery	acre	1.25	1.00	1.25
Labor (tractor & machinery)	hour	2.00	7.14	14.28
Labor (irrigation)	hour	1.75	4.00	7.00
Interest on Op. Capital	dol	.09	58.73	5.29
Subtotal, Preharvest				$122.74
Harvest Costs				
Defoliant	acre	$ 3.00	1.00	$ 3.00
Custom Spray	appl	2.00	1.00	2.00
Gin, Bag, Ties	bale	30.37	.91	27.64
Machinery	acre	10.86	1.00	10.86
Labor (tractor & machinery)	hour	2.00	1.57	3.14
Subtotal, Harvest				$ 46.64
Total Variable Costs				$169.38
3. Income Above Variable Costs				$ 61.42
4. Fixed Costs:				
Machinery	acre	$26.27	1.00	$ 26.27
Tractors	acre	8.89	1.00	8.89
Irrigation Machinery	acre	3.50	1.00	3.50
Land (net rent)	acre	45.00	1.00	45.00
Total Fixed Costs				$ 83.66
5. Total Costs				$253.04
6. Net Returns				$−22.24

APPENDIX TABLE 3. IRRIGATED COTTON, ESTIMATED COSTS, AND RETURNS PER ACRE OF CONVENTIONAL MANAGEMENT, LOWER RIO GRANDE VALLEY, TEXAS, 1973-75

	Unit	Price or Cost/Unit	Quantity	Value or Cost
1. Gross Receipts from Production:				
Cotton Lint	lbs	$ .45	435.00	$195.75
Cotton Seed	ton	95.00	.35	33.25
Total				$229.00
2. Variable Costs:				
Preharvest				
Seed	lbs	$ .30	20.00	$ 6.00
Fert. (60-40-0)	acre	20.00	1.00	20.00
Herbicide	acre	6.06	1.00	6.06
Insecticide	acre	25.96	1.00	25.96
Custom Spray	appl	1.38	12.00	16.56
Water Charge	appl	3.00	3.00	9.00
Machinery	acre	5.79	1.00	5.79
Tractors	acre	12.63	1.00	12.63
Irrigation Machinery	acre	1.25	1.00	1.25
Labor (tractor & machinery)	hour	2.00	7.14	14.28
Labor (irrigation)	hour	1.75	6.00	10.50
Interest on Op. Capital	dol	.09	64.00	5.76
Subtotal, Preharvest				$133.79
Harvest Costs				
Defoliant	acre	$ 3.00	1.00	$ 3.00
Custom Spray	appl	2.00	1.00	2.00
Gin, Bag, Ties	bale	30.37	.90	27.33
Machinery	acre	10.86	1.00	10.86
Labor (tractor & machinery)	hour	2.00	1.57	3.14
Subtotal, Harvest				$ 46.33
Total Variable Costs				$180.12
3. Income Above Variable Costs				$ 48.88
4. Fixed Costs:				
Machinery	acre	$26.27	1.00	$ 26.27
Tractors	acre	8.89	1.00	8.89
Irrigation Machinery	acre	3.50	1.00	3.50
Land (net rent)	acre	45.00	1.00	45.00
Total Fixed Costs				$ 83.66
5. Total Costs				$263.78
6. Net Returns				$-34.78

APPENDIX TABLE 4. DRYLAND COTTON, ESTIMATED COSTS, AND RETURNS PER ACRE OF SHORT-SEASON MANAGEMENT, LOWER RIO GRANDE VALLEY, TEXAS, 1973-75

	Unit	Price or Cost/Unit	Quantity	Value or Cost
1. Gross Receipts from Production:				
Cotton Lint	lbs	$ .45	477.00	$214.65
Cotton Seed	ton	95.00	.38	36.10
Total				$250.75
2. Variable Costs:				
Preharvest				
Seed	lbs	$ .30	20.00	$ 6.00
Fert. (40-30-0)	acre	13.90	1.00	13.90
Herbicide	acre	4.82	1.00	4.82
Insecticide	acre	1.81	1.00	1.81
Field Scouting	acre	2.00	1.00	2.00
Custom Spray	appl	1.38	1.00	1.38
Machinery	acre	4.80	1.00	4.80
Tractors	acre	5.39	1.00	5.39
Labor (tractor & machinery)	hour	2.00	3.76	7.52
Interest on Op. Capital	dol	.09	23.81	2.14
Subtotal, Preharvest				$ 49.76
Harvest Costs				
Defoliant	acre	$ 3.00	1.00	$ 3.00
Custom Spray	appl	2.00	1.00	2.00
Gin, Bag, Ties	bale	30.37	.99	30.06
Machinery	acre	9.15	1.00	9.15
Labor (tractor & machinery)	hour	2.00	1.35	2.70
Subtotal, Harvest				$ 46.91
Total Variable Costs				$ 96.67
3. Income Above Variable Costs				$154.08
4. Fixed Costs:				
Machinery	acre	$19.50	1.00	$ 19.50
Tractors	acre	3.66	1.00	3.66
Land (net rent)	acre	37.50	1.00	37.50
Total Fixed Costs				$ 60.66
5. Total Costs				$157.44
6. Net Returns				$ 93.42

APPENDIX TABLE 5. DRYLAND COTTON, ESTIMATED COSTS, AND RETURNS PER ACRE OF CONVENTIONAL MANAGEMENT, LOWER RIO GRANDE VALLEY, TEXAS, 1973-75

	Unit	Price or Cost/Unit	Quantity	Value or Cost
1. Gross Receipts from Production:				
Cotton Lint	lbs	$ .45	398.00	$179.10
Cotton Seed	ton	95.00	.32	30.40
Total				$209.50
2. Variable Costs:				
Preharvest				
Seed	lbs	$ .30	20.00	$ 6.00
Fert. (40-30-0)	acre	13.90	1.00	13.90
Herbicide	acre	4.82	1.00	4.82
Insecticide	acre	14.53	1.00	14.53
Custom Spray	appl	1.38	8.00	11.04
Machinery	acre	4.80	1.00	4.80
Tractors	acre	5.39	1.00	5.39
Labor (tractor & machinery)	hour	2.00	3.76	7.52
Interest on Op. Capital	dol	.09	34.00	3.06
Subtotal, Preharvest				$ 71.06
Harvest Costs				
Defoliant	acre	$ 3.00	1.00	$ 3.00
Custom Spray	appl	2.00	1.00	2.00
Gin, Bag, Ties	bale	30.37	.83	25.20
Machinery	acre	9.15	1.00	9.15
Labor (tractor & machinery)	hour	2.00	1.35	2.70
Subtotal, Harvest				$ 42.05
Total Variable Costs				$113.11
3. Income Above Variable Costs				$ 96.39
4. Fixed Costs:				
Machinery	acre	$19.50	1.00	$ 19.50
Tractors	acre	3.66	1.00	3.66
Land (net rent)	acre	37.50	1.00	37.50
Total Fixed Costs				$ 60.66
5. Total Costs				$173.77
6. Net Returns				$ 35.73

APPENDIX TABLE 6. IRRIGATED COTTON, ESTIMATED COSTS, AND RETURNS PER ACRE OF SHORT-SEASON MANAGEMENT, LOWER RIO GRANDE VALLEY, TEXAS, 1976-78

	Unit	Price or Cost/Unit	Quantity	Value or Cost
1. Gross Receipts from Production:				
Cotton Lint	lbs	$ .51	649.00	$330.99
Cotton Seed	ton	80.00	.52	41.60
Total				$372.59
2. Variable Costs:				
Preharvest				
Seed	lbs	$ .40	20.00	$ 8.00
Fert. (60-40-0)	acre	27.00	1.00	27.00
Herbicide	acre	6.63	1.00	6.63
Insecticide	acre	35.46	1.00	35.46
Field Scouting	acre	3.00	1.00	3.00
Custom Spray	appl	1.75	9.00	15.75
Water Charge	appl	3.50	2.00	7.00
Machinery	acre	7.37	1.00	7.37
Tractors	acre	19.06	1.00	19.06
Irrigation Machinery	acre	1.50	1.00	1.50
Labor (tractor & machinery)	hour	3.13	6.19	19.37
Labor (irrigation)	hour	2.63	4.00	10.52
Interest on Op. Capital	dol	.09	79.49	7.15
Subtotal, Preharvest				$167.81
Harvest Costs				
Defoliant	acre	$ 3.95	1.00	$ 3.95
Custom Spray	appl	2.00	1.00	2.00
Gin, Bag, Ties	bale	39.17	1.35	52.88
Machinery	acre	16.96	1.00	16.96
Labor (tractor & machinery)	hour	3.13	1.62	5.07
Subtotal, Harvest				$ 80.86
Total Variable Costs				$248.67
3. Income Above Variable Costs				$123.92
4. Fixed Costs:				
Machinery	acre	$28.72	1.00	$ 28.72
Tractors	acre	13.35	1.00	13.35
Irrigation Machinery	acre	3.50	1.00	3.50
Land (net rent)	acre	50.00	1.00	50.00
Total Fixed Costs				$ 95.57
5. Total Costs				$344.24
6. Net Returns				$ 28.35

APPENDIX TABLE 7. IRRIGATED COTTON, ESTIMATED COSTS, AND RETURNS PER ACRE OF CONVENTIONAL MANAGEMENT, LOWER RIO GRANDE VALLEY, TEXAS, 1976-78

	Unit	Price or Cost/Unit	Quantity	Value or Cost
1. Gross Receipts from Production:				
Cotton Lint	lbs	$ .51	487.00	$248.37
Cotton Seed	ton	80.00	.39	31.20
Total				$279.57
2. Variable Costs:				
Preharvest				
Seed	lbs	$ .40	20.00	$ 8.00
Fert. (60-40-0)	acre	27.00	1.00	27.00
Herbicide	acre	6.63	1.00	6.63
Insecticide	acre	43.30	1.00	43.30
Custom Spray	appl	1.75	9.00	15.75
Water Charge	appl	3.50	3.00	10.50
Machinery	acre	7.37	1.00	7.37
Tractors	acre	19.06	1.00	19.06
Irrigation Machinery	acre	1.50	1.00	1.50
Labor (tractor & machinery)	hour	3.13	6.19	19.37
Labor (irrigation)	hour	2.63	6.00	15.78
Interest on Op. Capital	dol	.09	87.13	7.84
Subtotal, Preharvest				$182.10
Harvest Costs				
Defoliant	acre	$ 3.95	1.00	$ 3.95
Custom Spray	appl	2.00	1.00	2.00
Gin, Bag, Ties	bale	39.17	1.01	39.56
Machinery	acre	16.96	1.00	16.96
Labor (tractor & machinery)	hour	3.13	1.62	5.07
Subtotal, Harvest				$ 67.54
Total Variable Costs				$249.64
3. Income Above Variable Costs				$ 29.93
4. Fixed Costs:				
Machinery	acre	$28.72	1.00	$ 28.72
Tractors	acre	13.35	1.00	13.35
Irrigation Machinery	acre	3.50	1.00	3.50
Land (net rent)	acre	50.00	1.00	50.00
Total Fixed Costs				$ 95.57
5. Total Costs				$345.21
6. Net Returns				$ −64.64

APPENDIX TABLE 8. DRYLAND COTTON, ESTIMATED COSTS, AND RETURNS PER ACRE OF SHORT-SEASON MANAGEMENT, LOWER RIO GRANDE VALLEY, TEXAS, 1976-78

	Unit	Price or Cost/Unit	Quantity	Value or Cost
1. Gross Receipts from Production:				
Cotton Lint	lbs	$ .51	592.00	$301.92
Cotton Seed	ton	80.00	.47	37.60
Total				$339.52
2. Variable Costs:				
Preharvest				
Seed	lbs	$ .40	20.00	$ 8.00
Fert. (40-30-0)	acre	18.70	1.00	18.70
Herbicide	acre	6.20	1.00	6.20
Insecticide	acre	3.21	1.00	3.12
Field Scouting	acre	3.00	1.00	3.00
Custom Spray	appl	1.75	1.00	1.75
Machinery	acre	6.46	1.00	6.46
Tractors	acre	12.86	1.00	12.86
Labor (tractor & machinery)	hour	3.13	4.30	13.46
Interest on Op. Capital	dol	.09	35.28	3.17
Subtotal, Preharvest				$ 76.72
Harvest Costs				
Defoliant	acre	$ 3.95	1.00	$ 3.95
Custom Spray	appl	2.00	1.00	2.00
Gin, Bag, Ties	bale	39.17	1.23	48.18
Machinery	acre	13.81	1.00	13.81
Labor (tractor & machinery)	hour	3.13	1.40	4.38
Subtotal, Harvest				$ 72.32
Total Variable Costs				$149.04
3. Income Above Variable Costs				$190.48
4. Fixed Costs:				
Machinery	acre	$23.54	1.00	$ 23.54
Tractors	acre	9.63	1.00	9.63
Land (net rent)	acre	40.00	1.00	40.00
Total Fixed Costs				$ 73.17
5. Total Costs				$222.21
6. Net Returns				$117.31

APPENDIX TABLE 9. DRYLAND COTTON, ESTIMATED COSTS, AND RETURNS PER ACRE FOR CONVENTIONAL MANAGEMENT, LOWER RIO GRANDE VALLEY, TEXAS, 1976-78

	Unit	Price or Cost/Unit	Quantity	Value or Cost
1. Gross Receipts from Production:				
Cotton Lint	lbs	$ .51	534.00	$272.34
Cotton Seed	ton	80.00	.43	34.40
Total				$306.74
2. Variable Costs:				
Preharvest				
Seed	lbs	$ .40	20.00	$ 8.00
Fert. (40-30-0)	acre	18.70	1.00	18.70
Herbicide	acre	6.20	1.00	6.20
Insecticide	acre	17.49	1.00	17.49
Custom Spray	appl	1.75	6.00	10.50
Machinery	acre	6.46	1.00	6.46
Tractors	acre	12.86	1.00	12.86
Labor (tractor & machinery)	hour	3.13	4.30	13.46
Interest on Op. Capital	dol	.09	46.84	4.22
Subtotal, Preharvest				$ 97.89
Harvest Costs				
Defoliant	acre	$ 3.95	1.00	$ 3.95
Custom Spray	appl	2.00	1.00	2.00
Gin, Bag, Ties	bale	39.17	1.11	43.48
Machinery	acre	13.81	1.00	13.81
Labor (tractor & machinery)	hour	3.13	1.40	4.38
Subtotal, Harvest				$ 67.62
Total Variable Costs				$165.51
3. Income Above Variable Costs				$141.23
4. Fixed Costs:				
Machinery	acre	$23.54	1.00	$ 23.54
Tractors	acre	9.63	1.00	9.63
Land (net rent)	acre	40.00	1.00	40.00
Total Fixed Costs				$ 73.17
5. Total Costs				$238.68
6. Net Returns				$ 68.06

ACKNOWLEDGEMENTS

We would like to express our sincere appreciation to all who contributed to this study. Ray Frisbie significantly improved the manuscript through editorial suggestions, and Richard Conner provided encouragement and advice. We are also indebted to Richard Shumway for editorial suggestions.

We are indebted to Glenn Collins and Dan Hardin for their assistance in developing appropriate computer programs. Finally, we are most grateful to Dianne Miller for her diligence and patience in typing several drafts of this manuscript.

This paper was supported in part by the Environmental Protection Agency through a grant (EPA Cooperative Agreement No. CR-806277-02-0) to Texas A&M University. The findings, opinions, and recommendations expressed herein are those of the authors and not necessarily those of the Environmental Protection Agency.

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